Fast Matching of Deformable Objects

Many applications such as UV-mapping, shape analysis, shape interpolation, sparse to dense reconstruction and partial scan-completion rely on the availability of a surface representation that is coherent across different instances, ie, each point on one surface maps to a point with the same semantic meaning on another. In the literature, the most common way to achieve coherence consists of explicitly computing and establishing correspondences between input representations, such as 3D meshes[1] or 3D point clouds[2]. Such a registration is discrete, and obtaining a continuous, smooth registration between the input representations is difficult and non-accurate.

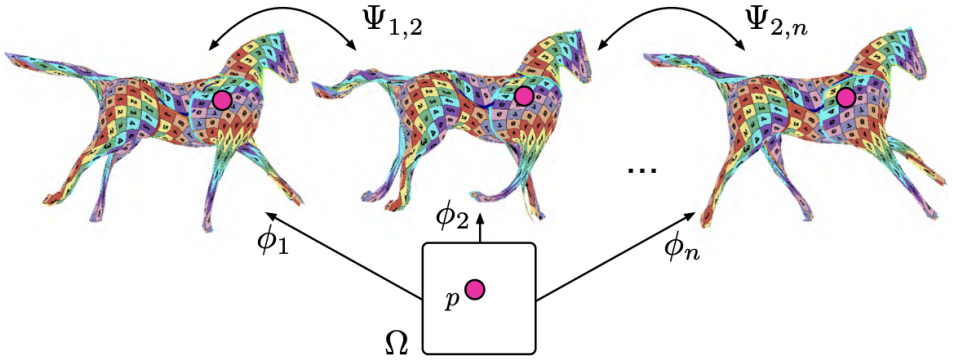

Figure 1: 4D registration performed in previous works

In our previous works[3], we tackled this problem more directly by learning to reconstruct temporally-coherent surfaces from a sequence of 3D point clouds representing a shape deforming over time (see Figure 1). This allows a compact, coherent representation of objects which can be easily used in the above-mentioned applications. In order to learn a dense registration, we rely on the preservation of intrinsic geometric properties of the shapes in addition to a global coherence by minimising distances between corresponding point sets. Such a formulation is accurate, robust but quite expensive which prohibits its usage in real-life scenarios. In this project, we aim to speed up the process. Our goal is to develop fast matching techniques that loosely preserve the intrinsic geometric properties so that a quick and decently accurate registration can be obtained. This requires approximation of intrinsic geometric properties using simpler mathematical formulations, such as normal and curvature analysis. Our focus will be on identifying and matching local structures with relatively unique surface properties.

The project will be jointly supervised by Dr. Shaifali Parashar (shaifali.parashar@liris.cnrs.fr) and Dr. Julie Digne (julie.digne@cnrs.fr). Interested students should drop an email with CV and transcripts.

Requirements: Strong background in computer vision, machine learning and mathematics with excellent programming skills (C++ and python) and fluency in English.

---

[1] Roufosse et al, ICCV 2019. Unsupervised deep learning for structured shape matching.
[2] Groueix et al, CGF 2019. Unsupervised cycle consistent deformation for shape matching.
[3] Bednarik et al, ICCV 2022. Temporally-Coherent Surface Reconstruction via Metric-Consistent Atlases.

Project duration: 6 months starting February 2023

Location: Lyon

Remuneration: 600 euros per month